AMENDMENT NO. 3 SEPTEMBER 2015
TO
IS 2386 (PART 7) : 1963 METHODS OF TEST FOR AGGREGATES FOR CONCRETE

PART 7 ALKALI AGGREGATE REACTIVITY

(*Page* 11, *clause* **2.4.1**, *Note* 1) — Substitute the following for the existing Note:

‘NOTE 1 — When a given quarried material is proposed for use both as coarse and as fine aggregate, test it only by selection of an appropriate sample crushed to the fine aggregate sizes, unless there is reason to expect that the coarser size fractions have a different composition than the finer sizes and that these differences might significantly affect expansion due to reaction with the alkalies in cement or from the environment of service. In this case, test the coarser size fractions in a manner similar to that employed in testing the fine aggregate sizes. ’

(*Page* 24, *clause* **3.10.4**) — Insert the following new clause at the end:

‘4 DETERMINATION OF POTENTIAL ALKALI REACTIVITY OF AGGREGATES (ACCELERATED MORTAR-BAR METHOD)

4.1 Object — This method of test permits detection, within 16 days, of the potential for deleterious alkali-silica reaction of aggregate in mortar bars.

4.2 Significance and Use

4.2.1 This method of test provides a means of detecting the potential of an aggregate intended for use in concrete for undergoing alkali-silica reaction resulting in potentially deleterious internal expansion. It is based on the NBRI Accelerated Test Method. It is especially useful for aggregates that react slowly or produce expansion late in the reaction. However, it does not evaluate combinations of aggregates with cementitious materials nor are the test conditions representative of those encountered by concrete in service.

4.2.2 Because the specimens are exposed to a NaOH solution, the alkali content of the cement is not a significant factor in affecting expansions.

4.2.3 When excessive expansions are observed, it is recommended that supplementary information be developed to confirm that the expansion is actually due to alkali-silica reaction. Sources of such supplementary information include: (a) petrographic examination of the aggregate to determine, if known reactive constituents are present; (b) examination of the specimens after tests to identify the products of alkali reaction; and (c) Use of field service records, where available, in the assessment of performance.

4.3 Apparatus

The apparatus shall consist of the following:

a) *Containers* — The containers shall be of such a nature that the bars can be totally immersed in either the water or 1N NaOH solution. The containers shall be made of material that can withstand prolonged exposure to 80 ºC and shall be resistant to a 1N NaOH solution (*see* Note 1). The containers shall be so constructed that when used for storing specimens, the loss or gain of moisture is prevented by tight-fitting covers, by sealing, or both (*see* Note 2). The bars in the solution shall be placed and supported so that the solution has access to the entire surface of the bar; therefore, it should be ensured that specimens do not touch the sides of the container or each other. The specimens, if stood upright in the solution, shall not be supported by the metal gauge stud.

NOTES

1 The NaOH solution will corrode glass or metal containers.

2 Some microwave-proof food storage containers made of polypropylene or high density polyethylene have found to be acceptable.

Price Group 2

b) *Oven, or Water Bath* — A convection oven or water bath with temperature control maintaining 80.0 ± 2.0 ºC.
c) *Other apparatus* — These shall be as given in **2.2**.

4.4 Reagents

4.4.1 *Purity of Reagent* – It shall be as given in **3.3.1**.

4.4.2 *Purity of Water* – It shall be as given in **3.3.2**.

4.4.3 *Sodium Hydroxide (NaOH)* – It shall be as given in **3.3.11**.

4.4.4 *Sodium Hydroxide Solution* – Each litre of solution shall contain 40.0 g of NaOH dissolved in 900 ml of water, and shall be diluted with additional distilled water to obtain 1.0 l of solution. The volume proportion of sodium hydroxide solution to mortar bars in a storage container shall be 4 ± 0.5 volumes of solution to 1 volume of mortar bars. The volume of mortar bar may be taken as 184 ml. Include sufficient test solution to ensure complete immersion of the mortar bars.

NOTE — For use of chemicals as specified in this standard, appropriate safety precautions shall be observed.

4.5 Conditioning

4.5.1 Temperature and humidity conditioning of the moulding room and laboratory shall be in accordance with **2.3.1** and **2.3.2.**

4.5.2 Maintain the storage oven or water bath in which the specimens are stored in the containers at a temperature of 80.0 ± 2.0 ºC.

4.6 Sampling and Preparation of Test Specimens

4.6.1 *Selection of Aggregate*

This shall be done in accordance with **2.4.1**.

4.6.2 *Preparation of Aggregate*

This shall be done in accordance with **2.4.2**.

4.6.3 *Selection and Preparation of Cement*

4.6.3.1 *Reference cement*

Use an ordinary Portland cement conforming to Indian Standard. In addition, the autoclave expansion as per IS 4031 (Part 3) : 1988 'Methods of physical tests for hydraulic cement: Part 3 Determination of soundness (*first revision*)' shall be less than 0.20 percent.

NOTE — The alkali content of the cement has been found to have negligible or minor effects on expansion in this test.

4.6.3.2 *Preparation of cement*

Pass cement for use in this test through an 850 µm IS sieve to remove lumps before use.

4.6.4 *Preparation of Test Specimens*

4.6.4.1 *Number of specimens*

Make at least three test specimens for each cement-aggregate combination.

4.6.4.2 *Preparation of moulds*

This shall be done in accordance with **2.5.2.**

4.6.4.3 *Proportioning of mortar*

Proportion the dry materials for the test mortar using 1 part of cement to 2.25 parts of graded aggregate by mass for aggregate with a relative density at or above 2.45. For aggregate with a relative density below 2.45, determine the aggregate proportion as follows:

$$\text{Aggregate proportion} = \frac{2.25 \times \text{Relative density}}{2.65}$$

4.6.4.3.1 For aggregates with a relative density equal to or greater than 2.45, the quantities of dry materials to be mixed at one time in the batch of mortar for making three specimens shall be 440 g of cement and 990 g of aggregate made up by recombining the portions retained on the various sieves in the grading prescribed in Table II. Use a water-cement ratio equal to 0.47 by mass.

4.6.4.3.2 For aggregates with a relative density less than 2.45, the quantities of dry materials to be mixed at one time in the batch of mortar for making three specimens shall be 440 g of cement and mass of aggregate shall be 440 g multiplied by the aggregate proportion determined in **4.6.4.3**. This aggregate mass shall be made up by re-combining the portions retained on the various sieves in the grading prescribed in Table II. Use a water-cement ratio equal to 0.47 by mass.

4.6.4.4 *Mixing of mortar*

This shall be done in accordance with **2.5.4.**

4.6.4.5 *Moulding of test specimens*

This shall be done in accordance with **2.5.5.**

4.7 Procedure

4.7.1 *Initial Storage and Reading*

Place each mould in the moist cabinet or room immediately after moulding for 24 ± 2 h at 27 ± 2 ºC and relative humidity equal to or more than 90 percent. Remove the specimens from the moulds and while they are being protected from loss of moisture, properly identify and make an initial and all subsequent readings to the nearest 0.002 mm. Place the specimens made with each aggregate sample in a storage container with sufficient tap water to totally immerse them. Seal and place the containers in an oven or water bath at 80.0 ± 2.0 ºC for a period of 24h.

4.7.2 *Zero Readings*

Remove the containers from the oven or water bath one at a time. Remove other containers only after the bars in the first container have been measured and returned to the oven or water bath. The time elapsed between removal and return of the specimens to the oven or water bath shall not exceed 10.0 min. Remove the bars one at a time from the water and dry their surface with a towel paying particular attention to the two metal gauge studs. Take the zero reading (*see* Note) of each bar immediately after drying, and read as soon as the bar is in position. Complete the process of drying and reading within 15 ± 5 s of removing the specimen from the water. After reading, leave the specimen on a towel until comparatory readings have been taken on the remainder of the bars. Place all specimens made with each aggregate sample in a container with sufficient 1N NaOH, at 80.0 ± 2.0 ºC for the samples to be totally immersed. Seal the container and return it to the oven or water bath.

NOTE — The reference bar should be read prior to each set of specimens since the heat from the mortar bars may cause the length of the comparator to change.

4.7.3 *Subsequent Storage and Measurement*

Make subsequent comparator reading of the specimens periodically, with at least three intermediate readings, for 14 days after the zero reading, at approximately the same time each day. If readings are continued beyond the 14 days period, take at least one reading per week. The procedure is identical to that described in the section on 'zero' readings except that the specimens are returned to their own container after measurement.

4.8 Calculation

4.8.1 Calculate the difference between the zero comparatory reading of the specimen and the reading at each period to the nearest 0.001 percent of the effective gauge length and record as the expansion of the specimen for that period. Report the average expansion of the three specimens of a given cement-aggregate combination to the nearest 0.01 percent as the expansion for the combination for a given period.

4.9 Report

4.9.1 Report the following information:

a) Type and source of aggregate,

b) Details of Portland cement used such as autoclave expansion and total alkali content as percent sodium oxide (Na_2O) equivalent ($Na_2O_{eq} = \%Na_2O + 0.658 \times \%K_2O$),

c) Average length change on percent at each reading of the specimens,

d) Any relevant information concerning the preparation of aggregate, including the grading of the aggregate when it differs from that given in **2.4.2**,

e) Any significant features revealed by examination of the specimens during and after test,

f) Amount of mixing water expressed as mass percent of cement, and

g) A graph of the length change data from the time of the zero reading to the end of the 16-day period.

ANNEX A

(*Clause* 4.2.1)

INTERPRETATION OF TEST RESULTS

A-1 Expansions of less than 0.10 percent at 16 days after casting are indicative of innocuous behaviour in most cases (*see* Note).

NOTE — Some granitic gneisses and metabasalts have been found to be deleteriously expansive in field performance even though their expansion in this test was less than 0.10 percent at 16 days after casting. With such aggregate, it is recommended that prior field performance be investigated. In the absence of field performance data, mitigative measures should be taken.

A-2 Expansions of more than 0.20 percent at 16 days after casting are indicative of potentially deleterious expansion (*see* **4.2.2**).

A-3 Expansions between 0.10 and 0.20 percent at 16 days after casting include both aggregate that are known to be innocuous and deleterious in field performance. For these aggregate, it is particularly important to develop supplemental information as described in **4.2.2**. In such a situation, it may also be useful to take comparator reading until 28 days. It may also be useful to support this test with mortar bar test at 38 °C and 60 °C as given in this standard, as applicable.'

(CED 2)

Publication Unit, BIS, New Delhi, India